Ministry of Natural Resources
Ontario

FOREST RESEARCH NOTE

1988 No. 46

Undercutting and wrenching of red pine, white pine and white spruce seedlings

G.J. O'Neill, M. Ditner and G.D. Racey

Introduction

Since the late nineteenth century undercutting of bare root seedlings has been practiced to produce sturdy trees with well branched root systems (Hastings 1923, Wahlenberg 1925, Olson 1930, Foster 1932 and Goudie 1935). Over the years, undercutting has gradually evolved into a technique to modify seedling morphology (Edgren 1975, Clearly et al. 1978) to solve specific problems in nursery stock production (Racey and Racey 1988).

Root wrenching was originally considered a part of the undercutting procedure (Goudie 1935), but later was developed into a distinct separate technique capable of modifying seedling morphology (Cameron and Rook 1969, Jakabffy 1969). However, optimal morphological modifications are the result of combining undercutting with various wrenchings (Abbot and Fitch 1977, Boyer and South 1984).

The objective of this study was to produce red pine (Pinus resinosa Ait.), white pine (Pinus strobus L.) and white spruce (Picea glauca (Moench Voss) seedling stock that would be morphologically similar to transplant stock by using a combination of undercutting, wrenching and reduced seedbed density.

Methods and Materials

In the spring of 1985, seedbeds of rising 2+0 red pine, white pine and white spruce were selected at the Midhurst Nursery (44° 27'N, 79° 45'W) for application of four undercutting and wrenching treatments (Table 1); a control (T_1), an operational transplant (T_2), a simulated transplant (T_3) and a thinned simulated transplant (T_4). Treatments were randomly assigned to plots varying between 34 to 75 m in length for T_1 and T_3. Treatment T_4 consisted of three separate 1 m plots within T_3. These 1 m plots were thinned to a density of 125 trees/lineal metre, the same as for T_2. Plots for T_1, T_3 and T_4 were replicated four times for red and white pine and three times for white spruce.

The root undercutting was done using a sharp, thin oscillating blade pulled through moist soil by a tractor at 1-1.5 Km/hr at a depth of approximately 5-7 cm. T_1 was not undercut while T_3 and T_4 were undercut on May 14 and July 3, 1985, for pine and spruce respectively. The timing of the undercut was to coincide with the operational transplant thus standardizing the initiation of treatments. Root wrenching was done with an Egedal lifting blade with beaters removed, when the soil was dry at a depth of 10-15 cm and a tractor speed of 3-4 km/hr. T_1 and T_2 were not wrenched, while T_3 and T_4 were wrenched once on June 10 and July 10, 1985, for pine and spruce respectively. Seedlings for the operational transplant (T_2) were lifted from four metre areas between each treatment in the spring of 1985.

Further information may be obtained from:

Ontario Tree Improvement and Forest Biomass Institute
Ministry of Natural Resources
P.O. Box 7400, Maple, Ontario, Canada L6A 1S9

89-04970/

Table 1 Dates of the undercutting and wrenching treatments for rising two-year-old red and white pine and white spruce.

Treatment	Species	Undercutting dates	Wrenching dates
T_1- Control	Pr,Pr Sw	None	None
T_2- Operational Transplant*	Pr,Pr Sw	None	None
T_3- Simulated Transplant	Pr,Pr Sw	May 14 Jul 3	Jun 10 Jul 10
T_4- Thinned Simulated Transplant	Pr,Pr Sw	May 14 Jul 3	Jun 10 Jul 10

* Red and white pine were operationally transplanted May 10, 1985 while white spruce was operationally transplanted July 3, 1985 to produce 1+2 pine and 1.5+1.5 spruce transplants.

These seedlings were transplanted by nursery personnel using normal operational procedures on May 10 and July 3, for pine and spruce respectively.

At the end of the 1986 growing season, a 15 tree sample of three-year-old seedlings was taken from each treatment for each replication, except from T_2 which had only one sample of 30 trees taken for all three species. The sampled trees were measured for top length, stem caliper, root volume, top dry weight (TDW), and root dry weight (RDW). A robustness coefficient (R), indicating seedling balance, was calculated by using the product of the stem caliper and root volume divided by top length. The closer the value of R is to 1, the better seedling balance and morphological characteristics.

$$\text{Eq. 1} \qquad R = \frac{\text{stem caliper (mm)} \times \text{Root volume (ml)}}{\text{top length (mm)}}$$

These morphological measurements were statistically analysized by one-way analysis of variance with differences among means compared, using Duncan's new multiple range test.

Results and Discussion

Effective undercutting and wrenching requires that the blade be brought up to speed before coming in contact with seedling roots. Failure to do so may result in seedlings wrapping around the blade and causing excessive disturbance to the seedbed. However, this was primarily a problem with undercutting or wrenching of small treatment blocks instead of entire seedbeds. Also, it is essential that the undercutting blade be sharp and rust-free to minimize soil disturbance and avoid a build up of soil or roots on the blade. On uneven ground, a spotter may be required to ensure uniform blade penetration during the treatment.

The second year undercutting and wrenching treatments did not affect stem caliper and TDW for all species by the end of the third year (Table 2).

Red pine seedling morphology was modified the most by undercutting and wrenching. T_3 and T_4 treatments produced similar top length values, which were significantly shorter than the control (T_1). This agrees with Bunting and McLeod (1984) who found that wrenching alone or combined with undercutting was effective at reducing shoot length of red pine. However, the T_3 and T_4 top lengths were significantly taller than T_2. The root volumes of all treatments were similar, except T_4, which had a significantly greater root volume than T_1.

Table 2 The various morphological measurements of three-year-old red and white pine and white spruce seedlings that were undercut and wrenched during their second year.

Treatment	Top length (cm)			Stem caliper (mm)			Root volume (ml)			Top dry weight (g)			Root dry weight (g)			Robustness coefficient (R)		
	Pr	Pw	Sw	Pr	Pw	Sw	Pr	Pw	Sw	Pr	Pw	Sw	Pr	Pw	Sw	Pr	Pw	Sw
T_1 Control	23.52a	20.41a	24.47	5.8	6.2	5.2	6.7b	11.0	4.5b	9.95	7.38	4.72	2.05b	2.85	1.43	.19c	.36	.10b
T_2 Operational Transplant	11.36c	15.80b	25.64	5.7	5.8	5.6	7.5ab	11.8	7.8a	8.64	6.99	5.53	2.08b	3.21	1.98	.38a	.45	.17a
T_3 Simulated Transplant	20.40b	20.45a	24.30	5.7	6.3	5.1	7.3ab	10.3	4.8b	9.59	7.61	4.83	2.14b	2.62	1.33	.22c	.37	.11b
T_4 Thinned Simulated Transplant	19.60b	16.77b	22.16	6.1	6.3	5.6	8.6a	11.6	6.7a	9.57	7.59	4.78	2.66a	2.77	1.93	.29b	.46	.17a
	*	*	ns	ns	ns	ns	*	ns	*	ns	ns	ns	*	ns	ns	*	ns	*

* Statistically significant at the 95% level.
ns Not statistically significant at the 95% level.
Values with the same letter are not statistically different at the 95% level.

The T_4 RDW was significantly greater from the other three treatments. Observations of three-year-old red pine roots showed that undercutting and wrenching (T_3 and T_4) stimulated more teritiary root formation than T_1, but less than T_2. The T_2 seedlings had the greatest robustness coefficient, while the T_4 R-value was significantly greater than that of T_3.

The effects of undercutting and wrenching on white pine were less pronounced than those on red pine. The T_4 top length was not significantly different from T_2, but was significantly smaller than that of T_1 and T_3. No significant differences were observed in root volumes, RDW or robustness coefficient. Observations of three-year-old white pine roots indicated that there was generally more secondary and teritiary root development in the undercut and wrenched seedlings (T_3 and T_4) than in the control (T_1), but less than in the transplants (T_2). Also, the secondary roots of the undercut and wrenched seedlings tended to be smaller in diameter than those of transplants.

The white spruce compartment had poor germination in 1984 and subsequent frost heaving resulted in low seedling density in the rising 2+0 year. Natural regeneration early in the second growing season from nursery windbreaks, increased seedling density which produced variations in seedling age and corresponding morphology. An attempt was made to isolate these seedlings from sampling, but it became increasingly difficult to detect them in the third growing season. However, the morphological variability created by the naturally regenerated seedlings can be considered to affect all samples equally. There was no significant difference among treatment top length and RDW. The root volumes for T_2 and T_4 were significantly greater than that of T_1 and T_3. Observations of three-year-old white spruce roots indicated that undercut and wrenched seedlings (T_3 and T_4) generally have the least amount of teritiary root development as compared to T_1 and T_2. However, undercutting and wrenching stimulated very long secondary root growth as compared to T_1 and T_2. The seedlings from treatment T_4 had an R-value significantly greater than that of T_3, but not from T_2, which indicates similar seedling morphology between the two treatments.

Conclusion

These findings demonstrate that root undercutting and wrenching of red and white pine and white spruce at seedling densities of 125 trees/lineal metre

(similar to transplant density) can modify the morphology of seedling stock to resemble transplant stock. The morphological response of seedlings tends to be species specific. Thus, further research into the precise timing of the undercut and wrenching, as well as the number of wrenchings will be required to successfully produce seedling stock morphologically similar to transplant stock.

Reducing seedbed density was as important to morphological modifications as the undercutting and wrenching treatments. This agrees with Mullin and Bowdrey (1977a, 1977b and 1978) and Edgren (1977) who found increase size and better balance (top/root ratio) from seedlings grown in low density properly spaced seedbeds. Therefore, spacing and density must be considered when developing and comparing undercutting and wrenching techniques.

Furthermore, it should be noted that a large bias exist when making comparisons of seedlings with transplants due to the culling of seedlings at transplanting time. As a result, the selected transplant seedlings will have superior morphological characteristics, which undercut and wrenched seedlings may not have.

References

Abbott, H.G. and S.D. Fitch. 1977. Forest nursery practice in the United States. J. For. 75: 141-145.

Boyer, J.N. and D.B. South. 1984. Forest nursery practices in the south. South. J. Appl. For. 8: 67-75.

Bunting, W.R. and G.R. McLeod. 1984. More root pruning and wrenching of rising 3+0 red pine. Ont. Min. Natur. Resour. Nursery Note 103. 5 p.

Cameron, R.J. and D.A. Rook. 1969. Wrenching as a means of conditioning planting stock. In Forestry nursery and establishment practice in New Zealand. N.Z. For. Serv., For. Res. Inst. FRI Symp. No. 9.

Cleary, B.D., R.D. Greaves and P.W. Owston. 1978. Seedlings p. 63-97. In B.D. Cleary, R.D. Greaves and R.K. Heiman, Regenerating Oregon's Forests. Oreg. State Univ. Ext. Serv., Corvallis, Oregon.

Edgren, J.W. 1975. Wrenching-recent developments in an old technique. p. 50-59. In Proceedings of Western Forest Nursery Council Meeting, Portland, Oregon. Aug. 5-7, 1974.

Edgren, J.W. 1977. Seedbed density, diameter limit culling, and 2+0 Douglas-fir seedling production. p. 1-13. In Proceedings of Western Forest Nursery Council and Intermountain Nurserymen's Association, Richmond, B.C., Aug. 10-12, 1976.

Foster, C.H. 1932. Improvements in planting stock production. J. For. 3: 212-214.

Hastings, W.G. 1923. Revolutionizing nursery practice. J. For. 21: 180-182.

Jakabffy, E. 1969. Rationalizing open ground nurseries: Undercutting and some suitable sowing methods. Sver. Skogsvards förb. Tidskr. 67: 425-440.

Mullin, R.E. and L. Bowdery. 1977a. Effects of seedbed density and nursery fertilization on survival and growth of 3+0 white pine. U.S. For. Serv., Tree Planters' Notes. 28 (1): 11-13, 39.

Mullin, R.E. and L. Bowdery. 1977b. Effects of seedbed density and nursery fertilization on survival and growth of 3+0 white spruce. For. Chron. 53: 83-86.

Mullin, R.E. and L. Bowdery. 1978. Effects of nursery seedbed density and topdressing fertilization on survival and growth of 3+0 red pine. Can. J. For. Res. 8: 30-35.

Olson, D.S. 1930. Growing trees for forest planting in Montana and Idaho. USDA Circular No. 120: 45-53.

Racey, J.E. and G.D. Racey. 1988. Undercutting and root wrenching of tree seedlings: an annotated bibliography. Ont. Min. Natur. Resour. For. Res. Rep. No. 121. 79 p.

Wahlenberg, W.G. 1925. Forestation research in Montana and North Idaho. J. For. 23: 589-599.

4190
(IKP.R. 88 09 23)
ISSN 0381-2660